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Preventive Maintenance and Malfunction Abatement Plan (PMMAP) for the Cupola Air Pollution Control System

Clow Water Systems Company
Coshocton, Ohio

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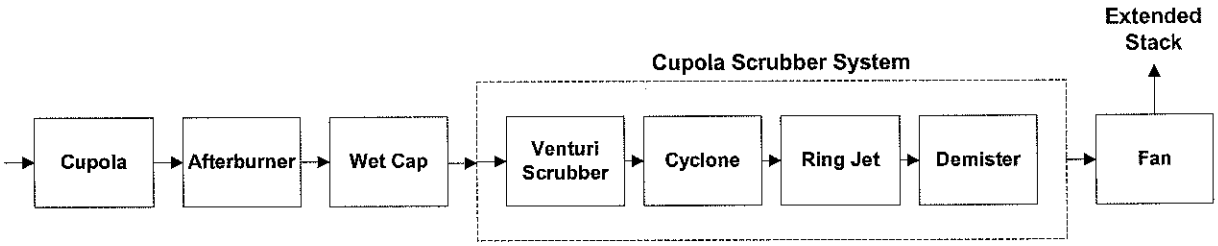
Section 1
Introduction

This Preventive Maintenance and Malfunction Abatement Plan (PMMAP) has been prepared incorporating the requirements of Ohio Administrative Code (OAC) rule 3745-15-06, considering Ohio EPA's *O&M Manual For Air Pollution Control,* equipment manufacturer's recommendations and experience.

The effective date of this PMMAP will be 60 days following approval by Ohio EPA.

1.1 Air Pollution Control System Overview

The cupola emission control system at the Clow Water Systems Company, Coshocton, Ohio facility consists of the following components:



Carbon monoxide, volatile organic compounds, and organic hazardous air pollutants are controlled by an afterburner. The afterburner consists of three in-stack burners. The burners are controlled based on the temperature detected by the upper stack thermocouple. Once the upper stack temperature meets the established setpoint, the burners are throttled to low fire to conserve gas and reduce emissions while still providing a source of ignition. If the upper stack temperature drops, burners throttle to high fire to ensure ignition and help maintain stack temperature.

Particulate emissions are controlled by a system of wet scrubbers. These scrubbers remove particulate, acid gases and metals employing state of the art technology in the method described below.

WET CAP

The wet cap is located at the top of the cupola stack. Here water is sprayed into the hot flue gases. As the water vaporizes the gas stream is cooled. The wet cap captures the coarse particulate matter.

VENTURI SCRUBBER

A **venturi scrubber** is designed to effectively use the energy from the exhaust stream to atomize the scrubbing liquid.

Clow's venturi scrubber consists of three sections: a **converging section,** a **throat section**, and a **diverging section**. The exhaust stream enters the converging section and, as the area decreases, gas velocity increases. Liquid is introduced either at the throat or at the entrance to the converging section. Particle and gas removal occur in the throat section as the exhaust stream mixes with the tiny liquid droplets.

The gas and water vapor mixture is then exhausted to a cyclone that provides initial separation of the particle-laden water from the air stream.

PACKED BED

The gases pass through a packed bed stage, counter current to the water, which cools the gases to about 150°F. The packing elements offer a large specific surface area, ensuring fast, efficient mass transfer between flue gas and scrubber water.

RING JET/DEMISTER

This is the polishing stage. Aerosols and submicron dust particulates generated in the cooling and absorption stage are collected in this stage. The flue gases pass a manifold of ring jets which are part of the multiple venturi configurations that subdivides the gas stream in order to increase separation efficiency. Controlled water supply makes it possible to hold a constant pressure drop and thus constant removal efficiency over a wide range of loads. The ring jet also offers high efficiency collection of gaseous contaminants such as sulfur dioxide.

The demister then removes the water droplets that have these submicron particles contained in them.

Finally two ID fans are used to induce gas flow through the system and exhaust the air out the cupola stack.

Section 2
Responsibilities and Training

The following section discusses responsibilities and training requirements of the PMMAP.

2.1 Responsibilities

Environmental Manager

- Overall PMMAP implementation.
- Any necessary reporting to Clow senior management and Ohio EPA.
- Investigation of abnormal operations.
- In coordination with the plant engineering and maintenance supervisor, establish preventative maintenance actions and frequency.
- In coordination with plant engineering and maintenance, development and implementation of the training program.
- Where conflicts exist, assign priority for repairs in consultations with the maintenance supervisor.
- Insure the integrity of the data collected.

Engineering Manager

- In coordination with environmental manager and maintenance supervisor, establish preventative maintenance actions and frequency.
- In coordination with environmental manager and maintenance supervisor, development and implementation of the training program.
- Secure and archive of all O&M manuals, drawings, equipment specifications, *etc.*

Maintenance Manager/Department

- Enter and maintain in an electronic database, the preventative maintenance tasks, as designated by the Environment Manager, Engineering Manager, and Maintenance Manager.
- Ensure all required preventative maintenance and repair are completed on a timely basis.

- Assign priority for repairs in consultations with the environmental manager, as necessary.
- Maintain work order records for designated period.
- Conduct assigned monitoring and recordkeeping duties.
- Complete inspections, preventative maintenance and repair tasks as assigned.

Purchasing Manager

- Maintain inventory of spare parts at or above the minimum established inventory.

2.2 Training

An overview of the PMMAP will be given to each responsible employee within 60 days from Ohio EPA approval of this plan.

Components of the training will include the following:

- Overview of Operation and Equipment Components
- Work Order System
- Inspection and Preventative Maintenance Responsibilities and Tasks
- Discussion/Location of available O&M Manuals
- Monitored Parameters and Values
- Recordkeeping
- Reporting of abnormal conditions

Section 3
Work Order System

This section discusses the work order system that is used to generate tasks associated with inspections, preventative maintenance and repair of equipment associated with the cupola emission control system and its related monitoring and recordkeeping equipment. The work order system has three functions including:

- Authorizing and defining the task to be performed.
- Verifying that the task has been completed
- Documenting frequency of repair and associated costs to assist in the evaluation of system performance and cost planning

The goals of the work order system are as follows:

- To provide authorization and instruction for the task that must be completed.
- To provide maintenance management the ability to plan and track time required to complete the tasks.
- To provide cost information including labor and materials for completing the repair.

3.1 Work Order System

Any task associated with inspections, preventative maintenance and required repairs are conducted by plant maintenance staff and are entered into and administered through a work order system (named "Maximo").

Each task is entered with any necessary instructions into Maximo. An example of a work order is provided in Appendix A. Depending on the activity, each task is assigned a frequency and level of priority regarding completion. The task frequency and repair priority is assigned based primarily on the potential effect on emissions and potential damage to the equipment. Availability of maintenance staff and safety are also considered.

Following completion of the work order, if applicable, maintenance staff must indicate the cause of the failure and changes that could prevent recurrence.

Section 4
Inspections and Preventive Maintenance

Preventative maintenance is an important tool in assuring continuous operation of the scrubber systems. Preventative maintenance programs for scrubbers should include periodic inspection of equipment, replacement of worn parts, periodic cleaning of components prone to plugging, maintenance of an adequate spare parts inventory, and recording of all maintenance on scrubber equipments.

In addition all instrumentation such as differential pressure gauges should be observed at least once per day. All equipment should be inspected regularly at intervals determined by the severity of service and the likelihood of component failure.

All worn parts and malfunctioning equipment should be serviced as they are discovered to prevent deterioration of system performance and to prevent damage to equipment. Records should be made of all maintenance performed and all parts replaced. This information is useful in planning subsequent preventative maintenance schedules and in determining the type and number of replacement parts needed.

The following inspections and preventative maintenance tasks have been established within Maximo.

4.1 Inspections and Preventative Maintenance Activities

Inspections and Preventive Maintenance will be performed on the following schedule:

APC	TASK	FREQUENCY
All	Inspect pumps seals	Daily
Afterburner	Check calibration of temperature monitoring system by checking temperature to a standard.	Monthly
Wet Cap, Venturi, Ring Jet	Inspect nozzles for blockage	Weekly

APC	TASK	FREQUENCY
Venturi, Cyclone, Ring Jet, Demister	Monitor static pressure across the scrubber system which is defined as the venturi, cyclone, ring jet and demister	Daily
Cyclone, Internal/External Demisters	Inspect for solids buildup	Monthly
Cupola Fan	Inspect for wear	Monthly
Scrubber	Ring Jet (Cleaning)	Weekly

4.2 Spare Parts Management

An inventory of key spare parts is maintained on-site. Minimum levels of each spare part is included in Appendix B. Based on operating experience the minimum levels may be revised from time to time.

These minimum levels are based on the probability of failure, cost of components, time to repair/obtain replacement part, and available space and manufacturer's recommendations and plant experience.

Section 5
Monitoring and Recordkeeping

The following monitoring will be conducted electronically, by manual documentation through monitoring sheets or by establishing a task within Maximo. Records will be kept according to applicable air permits and Clow policy.

5.1 Monitoring

APC	TASK	LIMIT	Monitoring or recording (?)
Afterburner	Monitor 15-minute average of combustion temperature.	>=1,300°F	Continuously
Venturi, Cyclone, Ring Jet, Demister	Monitor static pressure across the scrubber system which is defined as the venturi, cyclone, ring jet, and demister	>= 45 "w.g.	Daily

5.1.1 Combustion Temperature Monitoring and Compliance Determination

A thermocouple is maintained in the upper stack to monitor the combustion temperature and regulate the firing of the afterburners. The temperature is then electronically communicated and stored.

Ohio Administrative Code (OAC) 3745-21-08(D) states that no "person shall install a "new source", as defined by rule 3745-31-01 of the Administrative Code, from which the carbon monoxide gases generated during the operation of a gray iron cupola, blast furnace, or basic oxygen steel are emitted into the atmosphere, unless they are burned at 1,300°F for 0.3 seconds or greater in a direct-flame afterburner or equivalent device equipped with an indicating pyrometer which is positioned in the working area at the operator's eye level.

The above paragraph does not specify how a facility is to demonstrate compliance with the requirement. To demonstrate compliance with OAC 3745-21-08 (Control of carbon monoxide from stationary sources), Clow does the following:

1. Install, calibrate, maintain, and operate according to manufacturer's specifications a combustion zone temperature-measuring device that is located in the combustion zone. (NOTE: While this is a Title V requirement, the thermocouple cannot be calibrated nor can it be maintained.)
2. Install, calibrate, maintain and operate according to manufacturer's specifications a temperature monitor that is located in the melt office.
3. Record the combustion zone temperature every 1-minute.
4. Using the last 15 minutes record the rolling 15-minute average combustion zone temperature.
5. Maintain the rolling 15-minute average combustion zone temperature equal to or greater than 1,300°F.

Of special note regarding the above:

(a) Periods when the cupola is off-blast and for 15 minutes after going on blast from an off-blast condition are not included in the averages.

(b) Periods when on-blast but the cupola is not capable of producing molten metal are not included in the on-blast time (this occurs when the burning in the coke bed but prior to charging).

(c) Periods when on-blast and melting out the cupola (*i.e.* tapping the final iron of the day.

5.1.2 Cupola Scrubber System Pressure Differential

The pressure differential across the scrubber system is maintained at a minimum of 45 "w.g. (Δp) at all times.

Pressure monitors (transducers) are maintained to measure the scrubber system during all periods in which combustion air is being supplied to the cupola.

The data is collected and recorded on a data logger.

5.1.3 Alarms

Visible alarms have been established for when the combustion temperature drops below 1,300°F (15-minute average) and for the scrubber system pressure differential dropping below 45 "w.g.

The visible alarm for the combustion temperature and scrubber system pressure differential is located in the melt shop supervisor's office.

5.2 Recordkeeping

All monitored parameters will be kept on-site per the conditions of the permit and in compliance with Clow practices.

Section 6
Corrective Actions

This section discusses internal communication procedures and troubleshooting of the cupola emission control system.

6.1 Internal Communications

Any excursions below the rolling 15-minute average 1,300°F afterburner temperature is documented electronically and with a visible alarm. Should the rolling 15-minute average remain less than 1,300°F for 15 consecutive minutes the Environmental Manager and shift maintenance supervisor will be immediately notified.

Any excursions of the pressure differential of less than 45 "w.g. for the cupola scrubber system is documented electronically and with a visual alarm. Any alarm results in immediate notification of both the Environmental Manager and the shift maintenance supervisor.

The Environmental Manager shall be notified and Maintenance Department Manager jointly review and discuss PM inspection findings, including any identified follow up activities required and overall PMMAP implementation.

6.2 Troubleshooting

Wet scrubbers can provide continuous reliable service when they are operated properly and maintained regularly. Poor operation and maintenance leads to component failure. Most scrubber failures result from abrasions, solids buildup, and wear of rotating parts.

The troubleshooting chart provided below gives guidelines for causes and remedies of symptoms noted during inspections but the list is by no means exhaustive. Common failure modes for individual components are further discussed as follows.

Nozzle plugging is one of the most common malfunctions in scrubbers. Plugged nozzles reduce the liquid-to-gas ratio or cause misdistribution of the liquid. Nozzle plugging results from improper nozzle selection, excessive solids in scrubbing liquids, poor pump operations, and/or poor sump design. Remedies for nozzle plugging include replacement with nozzles of a different type, frequent cleaning, and reduction of liquid solids content by increasing liquid blowdown and makeup water rates. Nozzle plugging can be detected by observing the liquid spray pattern the nozzle produce. If the nozzles are not accessible while the pumps are

operating they should be checked during scrubber shutdown for evidence of caking over the nozzle openings. A decrease in water flow rate during scrubber operation is an additional symptom of nozzle plugging.

Solids buildup is another problem common to wet scrubbers and one that is often difficult to control. The tow types of solids buildup are sedimentation and chemical scaling. Sedimentation occurs when a layer of particles becomes attached to a surface or settles in areas of low turbulence. Sedimentation can lead to plugging of pipes and ducts or buildup on internal parts. Solids buildup may occur in piping, sumps, scrubber packing, instrumentation lines, or ductwork, and may lead to reduced scrubber efficiency and major equipment failure. Solids buildup can be detected by inspection of accessible components and by inspection of the inner surfaces of piping, tubing, and ductwork at removable fittings and hatches.

Abrasion can occur where gases or scrubbing liquids containing high concentrations of abrasive particles are in the turbulent mode or are subjected to a sudden change in flow direction. Typical wear areas in scrubbing systems include venturi throats, walls of the centrifugal mist collectors near the inlet duct, and elbows in the ductwork. Solutions to abrasion wear include the use of pre-cleaning devices and the use of large-radius turns in ductwork.

Rotating equipment including fans, pumps, and clarifiers must receive special attention in scrubber service because of potential abrasion, plugging, and corrosion. Key wear ears in these components include the bearings and any component rotating in the fluid stream.

Fan wear is a common problem. Forced-draft fans often suffer abrasion because of exposure to particulate-laden gases. Where problems in forced draft fans can be addressed by the use of special wear-resistant alloys and by reduction of fan rotating speeds.

Pump wear is also a common problem in scrubber systems. Pump housings, impellers, and seals are subject to abrasion and corrosion by scrubber slurries. Rubber linings and special alloy pump materials may be used to reduce abrasion and corrosions of the housings or impellers.

The following tables have been developed to assist in troubleshooting should a malfunction occur on either of these APC devices:

Troubleshooting Chart for Afterburner

SYMPTOM	CAUSE	REMEDY
Temperature below 1,300°F	Thermocouple faulty	Replace thermocouple
	Insufficient fuel	None
	Quenched air	None
	Limited gas to afterburners	Check gas supply
	Gas not mixed	Increase combustion air

Troubleshooting Chart for Scrubbers

SYMPTOM	CAUSE	REMEDY
Low pressure drop (scrubber section)	Low airflow rate	Check blower
	Low liquid flow rate	Check pumps/nozzles
	Eroded cleaning section	Inspect/repair
	Meters plugged	Clean lines
High pressure drop (scrubber section)	High airflow rate	Check blower
	Plugged in ducts or scrubber	Inspect/clean ducts
Low pressure drop (mist eliminator)	Low airflow rate	Check blower
	Low liquid flow rate	Check pumps/nozzles
	Media dislocated	Inspect/repair
High pressure drop (mist eliminator)	High airflow rate	Check blower
	High liquid flow rate	Check pump/nozzles
	Clogging	Inspect/clean
	Flooding	Inspect/drain
High temperature in stack	Insufficient wash liquor	Check pump/nozzles
	Liquid temperature too hot	Check sump temperature
Pump leaks Pump pressure increase	Worn packing or seals	Replace
	Nozzle plugging	Replace nozzles
	Valves closed	Open valves
Pump flow rate/pressure diminished	Impeller wear	Replace
	Nozzle abraded	Replace
	Speed too low	Check motor
	Defective packing	Replace
	Obstruction in piping	Check pipes, strainer, and impeller
Pump noise/heat	Misalignment	Check/repair
	Bearing damage	Replace
	Cavitation	Check/repair
Corrosion	Inadequate neutralization	Check pH control

SYMPTOM	CAUSE	REMEDY
Erosion	Incompatible materials	Replace materials
	High recycled solids content	Wastewater system
Scaling	Improper chemical treatment	Change treatment
Pipe plugging	High solids content	Cleaning
	Abrupt expansion/ contraction/bends	Change pipe fittings

Section 7
Deviations and Malfunctions

This section has two functions: 1) provide facility personnel with guidance on determining whether a deviation or a malfunction has occurred; and 2) identify the required reporting associated with a deviation or malfunction.

While this section can be easily modified and applicable to other emissions units, it is specific to the cupola. Depending on the requirements within the issued Title V permit this section may need to be modified before it is applicable to other emissions units at the Clow facility. Also, this section will more than likely need to be modified following revision or renewal of the Title V permit.

As an introduction, here are a few key points:

1. Deviations and malfunctions are exclusive of one another in all cases, except for one, when a malfunction occurs but is either not reported or incorrectly reported. This would then result in a deviation of the monitoring, recordkeeping, and reporting requirements and would need to be reported in accordance with the operating permit (see below).
2. Since deviations and malfunctions are exclusive, the first step is to determine if an event should be defined as a deviation or a malfunction.

   Per 3745-15-06(B)(1), a malfunction would be any event where the emission source, air pollution control equipment, or related facility breaks down in such a manner as to cause the emission of air contaminants in violation of applicable law.

   So a malfunction is a two-step process. First, has there been a "breakdown," and second, if there has been a "breakdown," was there emission above the permit limit has there been excess emissions?

   (Note: Though not discussed in this section, per 3745-15-06(A)(1), "maintenance of air pollution control equipment scheduled to prevent a malfunction which would occur within two weeks if the repairs were not performed shall be considered to be a malfunction...".)
3. A deviation would then be any exceedance from an emission limitation, operational restriction or control device operating parameter limitation that was not caused by a malfunction.

See Figure 1 for a flow diagram that should provide assistance in classifying an event as a deviation or malfunction and identify necessary reporting requirements.

Figure 1
Malfunctions and Deviations Flow Diagram

7.1 Deviations

There are two types of deviations discussed in Part I.A.1.c of the Title V permit. Those having to do with deviations from permit limits (emission limits, operations limits, control device operating parameters); and deviations from monitoring, recordkeeping, and reporting requirements. It is important to remember that deviations resulting from malfunctions are not reported as deviations as long as they are reported in accordance with OAC rule 3745-15-06.

7.1.1 Deviation Reporting

Emission Limits, Operational Restrictions, Control Device Parameters

Per the Title V, quarterly written reports of a deviation from federally enforceable emission limitations, operational restrictions, and control device operating parameter limitations (excluding deviations resulting from malfunctions reported in accordance with OAC rule 3745-15-06) that have been detected by the testing, monitoring, and recordkeeping requirements specified in this permit must be provided (see table below for requirements). The report must include:

1. the probable cause of such deviations;
2. any corrective actions or preventive measures taken, shall be promptly made to the appropriate Ohio EPA District Office or local air agency; and
3. the written reports shall be submitted quarterly, *i.e.*, by January 31, April 30, July 31, and October 31 of each year and shall cover the previous calendar quarters. (These quarterly reports shall exclude deviations resulting from malfunctions reported in accordance with OAC rule 3745-15-06.). If no deviations occurred a "no deviation" report must be submitted.

Current Cupola Emission Limits, Operational Restrictions, and Control Device Performance Parameters
■ A particulate emissions limit of 50 lb/hr. ■ A visible opacity limit from the scrubber stack of 20% as 6-minute average (except as provided by rule). ■ The pressure drop across the scrubber shall be continuously maintained above 45"w.g. ■ The cupola gases shall be burned at 1,300°F in a direct flame afterburner designed for a minimum of 0.3-second residence time.

Example deviations from limits, restriction, and parameters (assuming no malfunctions were occurring) would include:

- Stack test conducted and shown to exceed 50 lb/hr
- Pressure drop across the scrubber less then 45 "w.g. **(if the operator found the monitoring device was malfunctioning,**
- a 15-minute average combustion temperature was 1,220°F.

Monitoring, Recordkeeping, and Reporting

Written reports, which identify any deviations from the federally enforceable monitoring recordkeeping, and reporting requirements contained in this permit shall be submitted in accordance with the operating permit to the Ohio EPA Southeast District Office (SEDO) by January 31 and July 31 of each year for the previous six calendar months (see table below for requirements). If no deviations occurred during a six-month period, the permittee shall submit a semi-annual report, which states that no deviations occurred during that period.

Current Cupola **Monitoring, Recordkeeping, and Reporting**
■ Indicating pyrometer is positioned in the working areas at the operator's eye level.
■ Continuous monitoring of the static pressure drop across the scrubber and the afterburner temperature.
■ Record the scrubber pressure drop a minimum of every 2 hours.
■ Record the afterburner temperature each day.
■ Record the down time for the capture system, control device monitoring equipment, and the emissions unit.
■ Submit deviations reports if the pressure drop is out of range or the combustion temperature is less than 1,300°F.
■ Submit semi-annual reports (or no deviation reports) that identify all days during which any visible particulate emissions were observed from the scrubber stack.
■ Report any malfunctions as required by 3745-15-06(B).

Certifying Official

Note both of the deviation reports discussed above must be signed by a responsible official certifying that, based on information and belief formed after reasonable inquiry, the statements and information in the report are true, accurate, and complete.

7.2 Malfunctions

Malfunctions would be distinguished from **deviations** in that something must have malfunctioned, broken, *etc.*, generally in a sudden, unexpected, and unpreventable manner. Per 3745-15-06(B)(1), a malfunction would be any event where the emission source, air pollution control equipment, or related facility breaks down in such a manner as to cause the emission of air contaminants in violation of applicable law.

So a malfunction is a two-step process. First, has there been a "breakdown," and second, if there has been a "breakdown," have there been emissions in violation of applicable law.

Determining if there has been a "breakdown" is straightforward. The second step can be more difficult. For example, if the pump serving the venturi wet scrubber becomes inoperable has emissions of PM exceeded the current emissions limitation of 50 lb/hr if the cupola is stops charging right away?

Below are some additional examples:

- If due to a breakdown of equipment, the 15-minute average combustion temperature is less than 1,300°F, a malfunction has occurred because the applicable law requires temperature to be maintained at 1,300°F or greater.
- Water not being supplied to the ring jet would not be a malfunction because the venturi has shown to be able to meet the emissions limitations on its own.
- If the cupola cap goes up, Clow actually halts charging. It is unlikely that the PM emissions limit of 50 lbs/hr is exceeded but in this case Clow has agreed to notify Ohio EPA.

7.2.1 Malfunction Reporting

In the event a malfunction occurs in a manner to cause emissions of air contaminants in violation of any applicable law, Clow will immediately notify the Ohio EPA, SEDO.

If the malfunction continues for more than seventy-two hours, the source owner or operator shall provide a written statement to Ohio EPA, SEDO within two weeks of the date the malfunction occurred. The immediate notification and written statement shall include the following data:

(a) Identification and location of such equipment including the Ohio environmental protection agency permit application number for each air contaminant source;

(b) The estimated or actual duration of breakdown;

(c) The nature and estimated quantity of air contaminants which have been or may be emitted into the ambient air during the breakdown period;

(d) Statements demonstrating that:

(i) Shutdown or reduction of source operation during the breakdown period will be or would have been impossible or impractical;

(ii) The estimated breakdown period will be or was reasonable in duration based on installation or repair time, delivery dates of equipment, replacement parts, or materials, or current unavailability of essential equipment, parts, or materials;

(iii) Available alternative operating procedures and interim control measures will be or have been implemented during the breakdown period to reduce adverse effects on public health or welfare; and

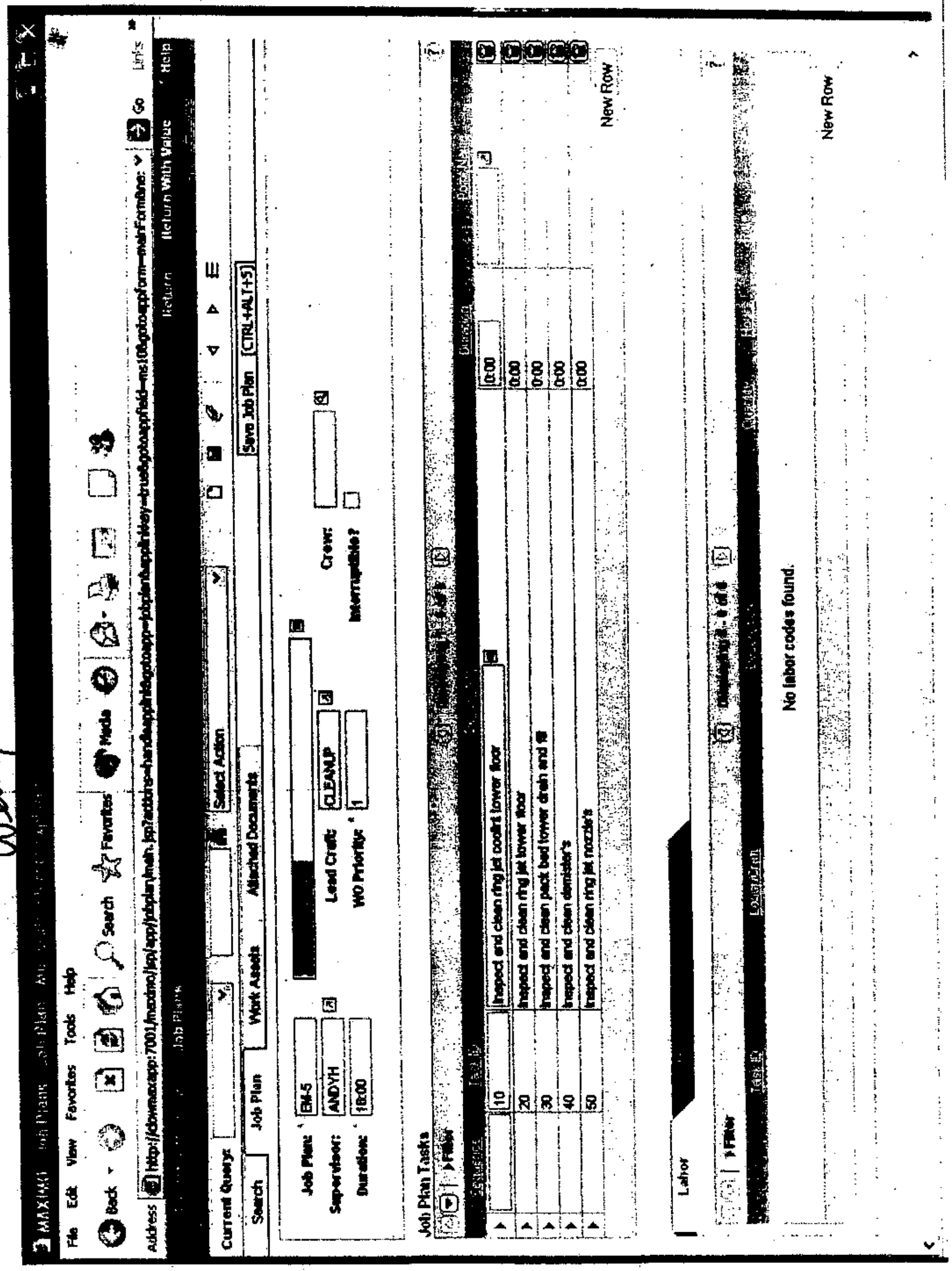
(iv) All actions necessary and required by any applicable preventive maintenance and malfunction abatement plan will be or have been implemented.

The Ohio EPA District Office or delegate agency will then be notified when the condition causing the failure or breakdown has been corrected and the equipment is again in operation. Notification of the correction of the condition causing the failure or breakdown may be given verbally if the duration of the malfunction is 72 hours or less. Otherwise, such notification shall be in writing.

Within two months following a failure or breakdown which exceeded 72 hours in duration, Clow will prepare and submit a detailed report which identifies a program to prevent, detect and correct, as expeditiously as practicable, similar future failures or breakdowns of such equipment.

Appendix A
Work Order Example

Weekly, Sat.



Job Plans
Current Query:
Select Action
Search
Job Plan
Work Assets
Attached Documents
Job Plan: EM-5
Supervisor: ANDYH
Duration: 18:00
Lead Craft: CLEANUP
WO Priority: 1
Crew:
Interruptible?
Save Job Plan [CTRL+ALT+S]
Job Plan Tasks
10 Inspect and clean ring jet coolant lower floor 0:00
20 Inspect and clean ring jet lower floor 0:00
30 Inspect and clean pack bed lower drain and fill 0:00
40 Inspect and clean demister's 0:00
50 Inspect and clean ring jet nozzle's 0:00
New Row
Labor
No labor codes found.
New Row
Return
Return With Value
Help

Appendix B
Spare Parts List

Emission Control System	PART or Subpart	Minimum QUANTITY
Afterburner	Thermocouple	2
Wet Cap	Pump Seals	3
Wet Cap	Pump Motor	1
Wet Cap	Pump Impeller	1
Wet Cap	Pump	1
Venturi	Pump Seals	3
Venturi	Pump Motor	1
Venturi	Pump Impeller	1
Venturi	Pump	1
Packed Bed	PB Recirculation Pump Seals	3
Packed Bed	PB Recirculation Pump Motor	1
Packed Bed	PB Recirculation Pump Impeller	1
Packed Bed	PB Recirculation Pump	1
Ring Jet	RJ Recirculation Pump Seals	3
Ring Jet	RJ Recirculation Pump Motor	1
Ring Jet	RJ Recirculation Pump Impeller	1
Ring Jet	RJ Recirculation Pump	1
Ring Jet	Scrubber Pump Seals	3
Ring Jet	Scrubber Pump Motor	1
Ring Jet	Scrubber Pump Impeller	1
Ring Jet	Scrubber Pump	1
All	Pump pressure gauge	1
Fan	Belts	1 set
Fan	Bearings	1 per type
Fan	Sheaves	1 per type

Jupiter Stips

per day	
$2K	1st - 14th
$4K	14th - 30th
$6K	31st - on